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The Relationship Between Structured Time and Self-Directed Cognitive Control in Early Childhood

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Abstract

How might the time that children spend in structured versus unstructured activities predict their executive function (EF), the set of control processes that govern thoughts and actions? Although extant research suggests that activities requiring self-directed practice improve child EF, no studies have examined how differences in *everyday* behaviors relate to EF. The present study considers how differences in executive functions in 6 and 7 year olds correlate with child time spent in structured and unstructured activities. Typical child activities were assessed using a weekly activity survey given to parents. Results indicate that the percentage of time children spent in unstructured activities predicted performance on the Verbal Fluency task, a measure of endogenous control, but not the AX-CPT, a measure of proactive control. These findings provide initial support for the hypothesis that the time children spend in unstructured activities may be associated with the development of self-directed behavior and contribute to developing endogenous control. This study has implications on future work on the development of executive functions and the importance of specific activities in childhood.

Keywords: Structured and Unstructured Schedules, Executive Function, Endogenous Control, Proactive Control, Leisure Time, Cognitive Flexibility

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Parents face complicated decisions about how and when to select activities that will prove optimal for their child's mental and physical well-being. Some parents fill their child's schedule with a series of adult-guided, highly structured activities, such as music lessons, language lessons, sports practice or math tutoring. Others take a relatively 'laissez-faire' approach to scheduling, and tend to encourage self-directed activities such as pretend play, media time or reading. Although a number of popular parenting books and columns have championed structured schedules over laissez-faire approaches, or vice versa, it is unclear whether these two parenting approaches impact child outcomes differently.

Within the scientific literature, no studies have directly addressed the question of whether 'laissez-faire' or, conversely, highly structured schedules are associated with better academic or cognitive outcomes in young children. Instead, most research has focused on how specific kinds of structured and unstructured activities relate to outcomes in older children and adolescents, and findings have been somewhat contradictory. For instance, studies have found that in middle school children, participation in clubs predicted academic grades and readiness, and participation in sports predicted psychological maturity and positive teacher ratings of social competence, while activities such as church did not predict any indicators of adjustment (Fletcher, Nickerson, and Wright 2003). By contrast, academic performance in adolescents was positively associated with unstructured activities such as socializing with friends (Bartko and Eccles, 2003). Although a recent cross-sectional study considered time use in younger children ages 4 through 8 (Fiorini and Keane, 2012), the authors focused analyses on types of caregiving rather than specific activites. Educational activities with parents (e.g., reading) predicted performance on a Picture Vocabulary Test more strongly than time spent in social activities, engaging with media, or in other general activities with adults (Fiorini and Keane, 2012). Given the mixed pattern of findings established by correlational studies of child schedules, it is critical that we consider *how* differences in child schedules might lead to differences in cognitive and academic outcomes.

Some Activities Improve Developing Executive Functions

Participation in specific activities may benefit a critical aspect of cognition known as executive function. Executive functions (EFs) are a set of control processes that govern thoughts and actions (Diamond, 2012; Miyake et al., 2000; Munakata, Snyder, & Chatham, 2012). Because EFs largely depend on the late developing prefrontal cortex (Anderson, Jacobs, & Anderson, 2008), the development of EFs occurs in early childhood and continues throughout adulthood. Strong EF skills facilitate learning and predict improvements in academic performance in both math and reading (Blair & Razza, 2007; Davidson, Amso, Anderson, & Diamond, 2006). Development of healthy executive function also predicts success in adult careers, marriage and health (Eakin et al., 2004; Gathercole, Pickering, Knight, & Stegmann, 2004; Prince et al., 2007). EFs show high heritability (Friedman et al., 2008); however, through targeted interventions, and enrichment activities, executive functions can be improved. Executive functions can be improved through targeted EF training, traditional martial arts, and specific school curricula (Diamond, 2012). There is also evidence to suggest that EFs can be improved through participation in aerobics (Davis et al., 2011), yoga (Manjunath & Telles, 2001) and mindfulness (Diamond & Lee, 2011). A review of these studies suggests that improvements in executive function vary based on the repetition of specific training activities, and how the activity is performed. Critically, activities which improve one executive function do not necessary improve other executive functions (Diamond, 2012).

In addition to structured activities such as martial arts, an unstructured activity – pretend play - may also be associated with developing cognitive abilities (Bodrova & Leong, 2003). Play has been linked to cognitive development by early theorists such as Jean Piaget (1962) and Lev Vygotsky (1978). Play has also been linked to advances in attention span, impulse control, problem-solving strategies, vocabulary and language comprehension (Smilansky & Shefatya, 1990). Free time and play are essential to the healthy development of children (Bodrova & Leong, 2003; Ginsburg, 2007; McHale, Crouter, & Tucker, 2012) but play has been displaced as parents have increasingly adopted a structured, hurried lifestyle (Ginsburg, 2007). Therefore there is reason to believe that time spent in unstructured activities such as play may prove to be associated with developments in executive functions. However, findings from a recent meta-analysis suggest that pretend play may not play a uniquely causal role in shaping EFs across development. Instead, pretend play may arise from EF improvements, as an epiphenomenon of other developmental advances, or pretend play may be one of many activities promoting EF development in young children (Lillard, Lerner, and Hopkins 2012). Although these findings challenge the characterization of pretend play as a singular driver of EF outcomes, the exact nature of the observed EF-play association is an important open question.

Critically, although isolated studies have considered the relationship between specific activities and EFs, no studies have considered how the *structure* of child schedules might relate to EFs. Previous studies have classified activities as either *leisure* and *non-leisure* time, wherein leisure time is made up of *freely chosen activities* (Meeks & Mauldin, 1990). In adults, freely chosen activities are those activities where the activity itself is the intrinsic motivator (e.g., reading a book for fun, or watching television). However, the activities children take up during leisure time are often dictated by adults. Therefore, child leisure time is typically broken down into structured leisure time and unstructured leisure time (Meeks & Mauldin, 1990). Structured leisure time includes activities that are driven and encouraged by adults or peers (e.g., competitive sports or music lessons), while unstructured leisure time includes self-directed activities such as play and reading, as well as social and family activities (e.g., picnics, parties, museum visits). Children who spend more time engaged in activities where rules and directions are established by adults may have different opportunities to develop executive function than children who spend more time in unstructured activities, as discussed in the next sections.

Endogenous Control

One aspect of executive function that might be impacted by child schedules is endogenous control, or the ability to switch from one behavior to another based on internal cues. For example, if a child gets stuck on a puzzle, they may engage their endogenous control to approach the puzzle in a different manner. A child without developed endogenous control strategies may have to wait until an exogenous cue, such as an adult telling them something is wrong, before they change their behavior. Children who are shuttled between adult-directed activities such as music lessons and sports practice (structured leisure time) may not have the same opportunity to exercise endogenous (internally-directed) control as children who are allowed to engage in self-directed activities (unstructured time). Additionally, children with highly structured schedules may have less opportunity to engage in pretend play. Pretend play requires children to employ internally guided rules (Lillard et al., 2012), which may benefit the development of endogenous control. For instance, a child who pretends to be a police officer during pretend play must select a set of rules and govern their behavior appropriately in order to adopt the role. The structured/unstructured tradeoff may directly affect the development of endogenous control in children, and extant studies have not considered how endogenous control differs as a function of the amount of unstructured activities a child participates in. Therefore there is reason to believe that *endogenous control* is one marker of executive function that may change with the structure of a child's schedule.

Proactive Control

Another element of executive function that may change with the structure of a child's day is *proactive control*, the ability to maintain robust goal representations and prepare for future events prior to those events happening, rather than reacting to them (Munakata et al., 2012). Children who act proactively maintain abstract information about the future, whereas children who act reactively modulate their behavior in response to immediate environmental cues. Proactive control is a component of cognitive flexibility (the ability to shift between competing sets of rules in order to carry out an appropriate action), which may correlate with a child's time in either structured or unstructured time. By taking an active role in future-oriented thinking, children who engage in self-directed unstructured activities may create goals and carry out actions in service of those future goals. For example, a child might decide that they want ride their bike tomorrow. In order to fulfill this goal, they need to take actions such as make sure the tires are filled, find their helmet, etc.

Conversely, children who participate in many structured activities may also see improvements in proactive control – or they may choose structured activities because they have well-developed proactive control. Participating in structured activities may require children to learn rules that they must keep in mind and generalize across novel activities (Kharitonova & Munakata, 2011). For example, if a child goes to soccer practice, they may learn and practice keeping rules about teamwork in mind; in the future, they may gain practice generalizing those rules to situations such as school group projects, and getting along with siblings. Additionally, children with better self-regulation skills may be granted more opportunities to engage in structured lessons.

This study contributes to the existing child scheduling debate by exploring the association between structured and unstructured schedules and two executive functions: endogenous control and proactive control. We hypothesize that performance on an endogenous control task should have a positive relationship with the amount of time spent in unstructured leisure time, since children should have more opportunity to practice self-regulation during unstructured activities. We investigate two competing hypotheses relating to performance on the proactive control task. On the one hand, proactive control could benefit from unstructured leisure time, since self-directed activities may allow children to develop plans based on abstract goals. On the other hand, it is also possible that proactive control may be positively associated with highly structured schedules, because children with better proactive control may choose (or be granted more opportunities to participate in) more structured activities.

Methods

Participants were 34 (18 male, 16 female) children aged between 6 years and 7 years (M=6.62; 6.08-7.01). All subjects were recruited from the University of Colorado Boulder Cognitive Development Center (CDC) database. All participants spoke English as their first language; bilingual children were not recruited for this project. Twenty-eight participants were Caucasian, 1 was Asian, and 5 did not disclose race information. Most participants were affluent (median household income between 100-124.9k per year); however, reported incomes ranged from 25k to over 150k per year. When parents were contacted for this project, they were advised that they would be asked to document child activities via a time diary survey during the testing visit, and were encouraged to document the week's events in preparation for the upcoming appointment. Parental consent was obtained at the time of the site visit, prior to child testing. Children received small gifts (e.g., gliders, balls) throughout the project for their participation and a certificate at the end of the session. Parents received $5 as compensation for travel.

During the site visit, parents completed the Parent Survey, which included subsections relating to demographics, weekly child activities (including the Weekly Scheduling Time Diary) and parenting practices. While parents completed the survey, child participants were guided through a measure of proactive control (AX-CPT), a measure of endogenous control (verbal fluency), and a control measure (expressive vocabulary task), as well as two other cognitive tasks that are not the focus of this study (Digit Span and Flanker). All subjects completed all tasks with the exception of 1 subject who failed to generate a score on the AX-CPT due to equipment failure.

Child tasks

Verbal Fluency Task. Children were asked to complete a verbal fluency task to assess endogenous control (Snyder & Munakata, 2010). Prior to the task, the experimenter instructed children that they would get tokens for each word they produced that fell under a given category in a set period of time. The experimenter then provided a categorical prompt (either animals or food). Children were allowed 1 minute to generate as many different words as they could think of. After completion of the first category, the task was repeated using the category not used during the first session. Order of category presentation was counterbalanced across participants, and the experimenter provided no prompts to children during the task.

To maximize their performance on the verbal fluency task, children must switch between subcategories in a self-directed way, an act that requires endogenous control. To illustrate: children often find it difficult to name words from a single category for an entire minute. After naming a few words, most children struggle to come up with new words. Once this wall is hit, children have two options: they can perseverate on the set of words they named, or they can switch to a new set of words. A child without developed endogenous control fails to switch and perseverates on a single category, often repeating the same word until time runs out.

Expressive Vocabulary Test (EVT). Children completed a standard picture vocabulary assessment to serve as a control for individual differences in verbal knowledge, which may have contributed to performance on the verbal fluency task. During the EVT, children were asked to identify presented pictures using one word, or to produce synonyms for known words (e.g., "What is another word for rock?"). Each child was presented age-indexed words from a set of 38 labeling items and 152 synonym items. Children continued to answer questions until they incorrectly answered five questions in a row.

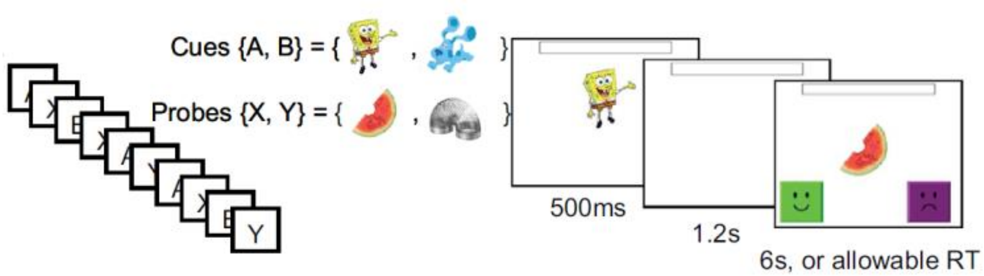

Figure 1. Design of the child-adapted AX-CPT. Children responded to cue-probe sets, as shown on the left. The cues were the cartoon characters Blue and Spongebob. The probes were either a watermelon or slinky. The sequences always occur in the order cue, delay, probe, as shown on the right (Chatham et al., 2009).

AX-CPT. Participants completed a touchscreen-based, child-friendly version of the AX Continuous Performance Task (AX-CPT) designed to measure proactive control (Chatham, Frank, & Munakata, 2009). This task allows children to prepare for future circumstances (the appearance of either “X” or “Y” probes) based on previous experiences (the appearance of “A” or “B” cues). The child-adapted version utilizes cartoon characters and pictures for the cues and probes (Figure 1). Cue and probe presentation were counterbalanced. Cues (either “A” or “B”) were presented for 500ms, and were immediately followed by a delay period (120ms). After the delay, a probe appeared (either “X” or “Y”) for 6s. Children responded with the target response (a happy face) whenever the “X” probe followed the context cue “A”, which occurred in 70% of trials. The remaining 30% of trials required children to press the non-target (sad face) response to other cue-probe sequences (“A” then “Y”; “B” then “X” or “B” then “Y”). After 4 sets of 30 trials, children were given a prize for completing the task.

Due to the asymmetry in cue-probe pairings (70% of AX 30% for AY, BX, BY) context specific cues (either “A” or “B”) served as an indicator for advanced preparation and proactive control. Children engaging in proactive control should demonstrate low reaction times in BX and BY trials, since they are proactively maintaining the “B” cue. However, proactive maintenance comes at the cost of performance on the AY pairing. Active maintenance of the “A” cue causes interference on AY pairings, resulting in slower reaction times for this cue-probe pair.

Parent Survey

Parents completed a survey designed to measure various facets of the child’s day-to-day life, including demographics and schooling information, a weekly scheduling time diary, typical free time and play activities, and an intrusive (‘helicopter’) parenting scale. This paper presents focused analyses relating to the first part of the survey. Other data collected in the survey will be utilized in future research.

Weekly Scheduling Time Diary. The weekly time diary captured information about the child's activities during the week prior to the testing session. The parent accompanying the child was asked to provided brief but specific textual descriptions of the child's activities in thirty-minute increments (see Table 1). Parents were instructed to include as much detail as possible about activities. Examples of appropriate responses were provided in the task instructions (e.g., instead of indicating "drove to Boulder," an appropriate response would be "Watched DVD with sister in the car while driving to Boulder for a research appointment"). Experimenters encouraged parents to refer to materials that would assist their recall of events (e.g., written notes, daily calendar) while filling out the survey. Likert-scaled questions gauging scheduling were also included in this section to determine whether the prior week was representative of the child's typical schedule (e.g., "How much does your child's Monday-Friday [Saturday-Sunday] schedule typically vary from week to week?"; "Was your family's schedule last week unusual or atypical?").

	Monday	*Tuesday*	*Wednesday*	*Thursday*	*Friday*
2:00 PM	Drove home from school	Drove home from school	Afterschool day care	Played with brother on playground	Drove home from school
2:30 PM	Homework	Piano lessons	Piano lessons	Drove to soccer	Played outside
3:00 PM	Homework	Piano lessons	Piano lessons	Soccer practice	Watched TV

Table 1. *Example Weekly Time Diary (segment).* Parents completed a Weekly Scheduling Time Diary, specifying child activities during the previous week in 30-minute increments. Parent responses were coded according to type of activity. For example, less structured activities such as *playing outside* were coded differently than more structured activities such as *piano lessons* (see Appendix 1).

Helicopter Parenting Subscale. This subscale of the Parent Survey was developed to assess typical patterns of parent intrusion into child activities (adapted from Lemoyne & Buchanan, 2011 by J. Obradovic; personal communication, October 26, 2011). Items measured parents' agreement with statements such as, "I feel the need to be the voice for my child so that things go my child's way," and "It is important to me that my child never fails in activities". Helicopter parenting subscale questions can be found in Appendix 2.

Analysis

AX-CPT. Reaction times and response accuracies were recorded in the AX-CPT task, which provided an index of proactive and reactive control. Subject data was trimmed such that only correct trials where responses occurred >200ms after stimulus presentation were included in the analysis, in order to exclude accidental responses. Average reaction times from correct trials on each trial type were z-transformed with respect to each subject's median RT across all correct, trimmed trials. For each subject we calculated an index of reactive/proactive behavior by comparing performance on AY and BX trials across all trials. This z-transformed difference score was normalized to account for individual differences in response latencies, so that the resulting proactive index was generated by the formula (AY-BX)/(AY+BX). Positive, z-transformed reaction times indicate a slowing on AY trials compared to BX trials, which is indicative of proactive behavior.

Verbal Fluency. Responses for each participant were recorded on audiocassette, and then transcribed by three separate coders. Responses for animal and food categories were coded separately. There were no significant differences in switching score between the two categories, and performance on the two was correlated ($r(32)=.48$, $p<.01$). Within each category, coders identified clusters of words that were semantically similar (e.g., "Gorilla", "Monkey", "Chimp" or “Tiger”, “Lion”, “Cheetah”). In order for a set of words to be considered a category, the child had to generate two words from a category, followed by a distinctly different word or set of words. Verbal fluency scores were generated by calculating the amount of distinct switches within a set of words. For example, if the child provided 9 words in groups of 3 categories, (e.g., “Gorilla, monkey, chip, tiger, lion cheetah, fish, whale, dolphin”) the child switched twice, first from the primate category, then from the great cat category, resulting in a switch score of 2. This raw score was then weighted, as follows: one point was awarded for a switch after a cluster of two related items, two points were awarded for a switch after a three item cluster, etc. The weighted switch score reflects children’s ability to cluster words and then switch between clusters - a behavior that is indicative of self-directed control - without penalizing children who generate several words within each category (Snyder & Munakata, 2010). Scores across both sessions (food and animals) were combined to form a composite switch score. Self-directed switches between different sub-categories (e.g., from zoo animals to ocean animals) indexed endogenous control, with more switches indicating a higher degree of endogenous control.

Weekly Scheduling Time Diary[1]. Typed parental responses were exported in their raw form, and then coded into pre-determined categories based on areas of interest that were targeted at the outset of this study (e.g., structured versus unstructured activities; see Appendix 1). Codebooks were initially generated based on example entries contributed by study research team members, and augmented by examples pulled from the time diaries of pilot subjects[2]. Each parent text entry was coded by two different individuals who had been trained to code activities

[1] In the future, inter-rater reliability analyses will be conducted to reduce coding errors and to ensure that analyses are free of systematic bias. Because this project is still in the pilot stage, no IRR analyses have been conducted at this point.

[2] Separate coders coded the first 18 participants independently, and later reconciled their codes in order to develop the codebook used for subsequent subjects. The final 16 subjects were coded by only one of the original coders. This coder used the codebook created following the first 18 participants. Subsequent analyses will employ two independent coders for all analysis.

using the codebook. Each response was assigned a primary code. Some entries also required a secondary code; however, for the purposes of this study, only primary activities were considered in the analysis. In order to generate the codebook, coders met to resolve discrepancies between independently coded entries. These meetings allowed for clarification on certain activities and also assisted in the creation of new codes when previous codes were not descriptive enough. For example, after looking at play time codes, (6.01-6.04/6.11-6.14) certain activities seemed to be qualitatively different. Playing indoors and bowling indoors would both result in 6.11 codes; however, the rules involved in bowling created a more structured play environment. As a result, coders established a structured play time code (6.15).

While we tried to capture all typical (and atypical) child activities, including eating, school, chores and sleep, we were particularly interested in how children spent their leisure time (Meeks & Mauldin, 1990). Most importantly, we classified play codes (beginning with 6.0) according to two major categories: indoor versus outdoor; and alone versus with others (Appendix 1).

The other focus of this study was to look at participation in structured activities. Codes 2.0 through 5.0 were assigned to entries relating to participation in and practice of structured activities. Physical activities such as soccer and karate were coded as a 2.0; structured activity practice was assigned a code of 3.0. Non-physical structured activities (drawing, music lessons) and their corresponding practice sessions were assigned codes 4.0 and 5.0, respectively.

Results

As predicted, performance on the Expressive Vocabulary Task (EVT) correlated with verbal fluency switch score $r(32)=.466$, $p<.01$, replicating previous findings (Snyder & Munakata, 2010). Therefore, partial correlations controlling for EVT are reported in the following sections.

On average, children spent 30 hours per week in school and 74 hours per week sleeping. Twenty-three hours a week were devoted to non-leisure activities such as brushing teeth, driving, and eating. Therefore, approximately 34 hours per week were devoted to either structured or unstructured leisure activities. Table 2 breaks down the distribution of time children spent in coded activities, on average, in minutes per day. Table 3 indicates correlations between specific activities and indicators of executive function.

Unstructured Leisure Time. Unstructured leisured time activities amounted for the majority of the child's day outside of school and sleep. This time consisted of play, practicing for physical/non-physical lessons, casual family outings, parties, and other unstructured parent interactions (e.g., discussions, coloring, preparing food). The amount of time spent in unstructured activities correlated with the endogenous control measure, verbal fluency, before and after controlling for EVT performance ($r(31)=.39$, $p<.05$; Figure 2). The amount of time spent in unstructured activities did not correlate with proactive control (Figure 3).

Structured Leisure Time. The structured leisure time category includes all adult-directed activities taking place during leisure time. This includes structured physical and non-physical lessons (e.g., music and soccer) as well as time spent on homework and religious activities. There were no significant correlations between time spent in structured leisure time and either verbal fluency or the proactive control measure (Figures 2 and 3).

Table 2

Average Minutes per Day Spent in Coded Activities

Activity	**Average Minutes Per Day**	**Standard Deviation**
Leisure	**295.21**	**147.37**
Unstructured	**258.15**	**135.23**
Practice	2.14	5.51
Play Alone	86.72	75.51
Play Others	104.87	68.1
Parent-child interaction	12.1	17.57
Parties/Social Events	6.81	10.4
Family Outings	45.5	45.18
Structured	**37.06**	**56.57**
Lessons	20.29	32.88
Homework	13.49	30.05
Religious Activities	3.28	6.25
Non-Leisure	**199.41**	**67.01**
Eating	74.37	33.56
Chores	11.47	13.91
Personal Care	44.75	25.24
Family Outings Prep	4.66	7.85
Appointments	1.51	4.82
Commuting	62.65	34.25
Sleep	629.12	42.87
School[1]	247.64	64.8
School[2]	346.7	90.72

[1]Average time spent in school, excluding summer subjects.
[2]Average time spent in school, excluding summer subjects, adjusted for weekend time.

Table 3

Participation in activities correlated with Verbal Fluency Switch Scores and child proactive index

Activity	**VF Switch Score (Controlled for EVT)**	**Proactive Index**
Leisure	**.345***	**.094**
Unstructured	.393*	.052
Family outing	.466**	-.19
Play	.254	.142
Reading	.178	.253
Physical lesson practice	-.055	-.274
Non physical lesson practice	.082	.008
Social event/ party	.302§	.118
Parent-child interaction	.058	.073
Structured	*-.039*	*.257*
Structured physical lessons	-.085	.177
Structured non-physical lessons	-.040	.236
Homework/studying	.077	.123
Religious Activities	-.079	.016
Non-Leisure	**-.042**	**.147**
Eating	-.032	.028
Chores	.278	-.046
Personal Care	-.260	.312
Preparing for family outings	.049	-.191
Child appointments	.014	-.003
Commuting	.011	.104
Helicopter Parenting Index	**-.299**§	**-0.180**

Note: Significance indicated as follows: *p<.05 **p<.01 § 0.1<p<.05

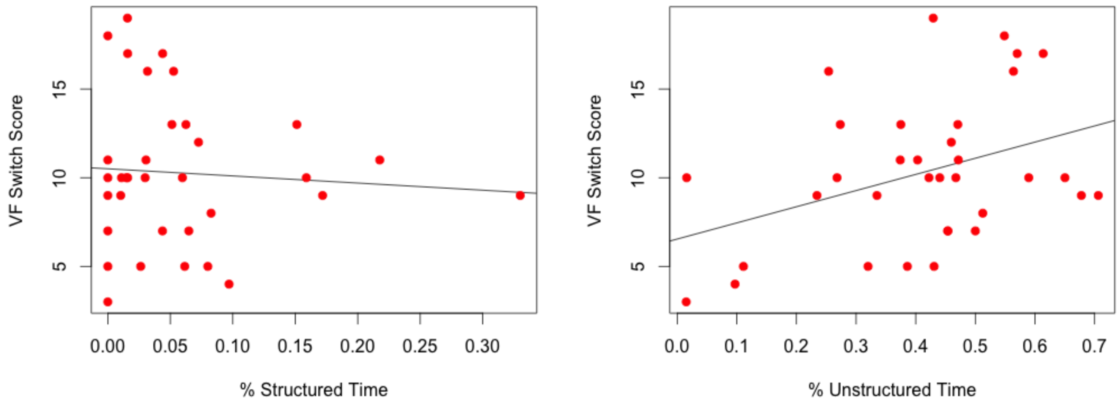

Figure 2. Correlation between time spent in structured and unstructured activities (outside of sleep and school) and Verbal Fluency Switch Score. There is a medium strength positive correlation (*r*(31)=.39, *p*<.05).

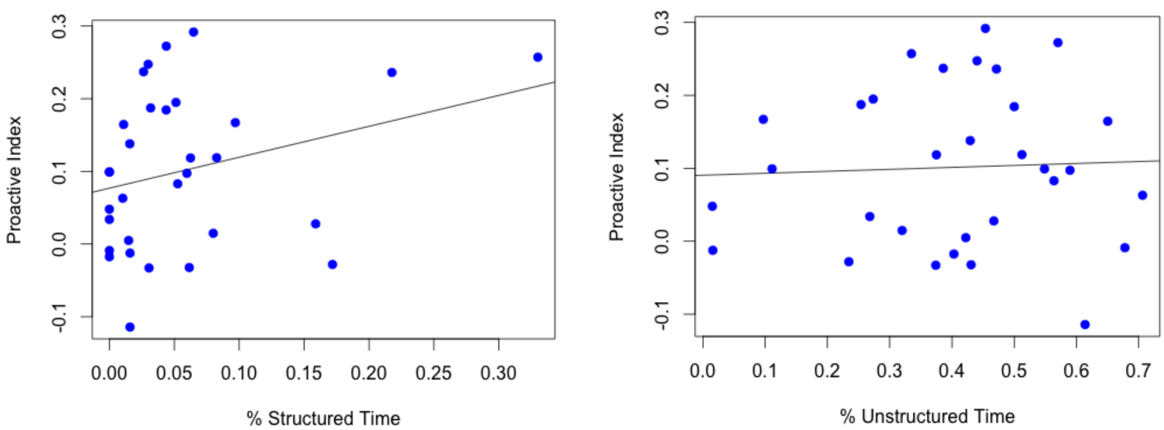

Figure 3. Correlation between time spent in structured and unstructured activities (outside of sleep and school) and the Proactive Index as measured by the AX-CPT. There are no significant correlations.

Helicopter Parenting Subscale. Helicopter parenting scores (M=20.94; SD= 4.16) marginally predicted Verbal Fluency Switch Scores ($r(31)=-.299$, $p=.09$) such that the children of parents who indicated a more intrusive parenting style demonstrated lower switch scores, on average. Helicopter parenting scores did not predict differences in child proactive index ($p>.3$), and were not correlated with time spent in unstructured ($p>.9$) or structured activities ($p=.15$)[3]. One parent did not complete the subscale.

Discussion

The results support our prediction that the amount of time children spend in unstructured leisure time would positively correlate with their performance on an endogenous control task. Time spent in unstructured leisure time predicts improved performance on Verbal Fluency, a measure of endogenous control. This positive relationship can be interpreted in either of two ways. Activities that occur during unstructured leisure time, such as play, may foster self-directed behavior. Alternately, parents with self-directed children may allow their children to engage in more unstructured behaviors. Similarly, the marginal relationship between intrusive, or helicopter, parenting and endogenous control can be explained in different ways. Intrusive parenting may reduce the number of opportunities children have to practice endogenous control, which may have contributed to poorer scores on the verbal fluency task Alternatively, children without developed endogenous control may rely on their parents to direct their activities. The correlational design of this study does not allow us to determine the directionality of these relationships. However, the current literature on executive functions supports the idea that environments may influence developing executive functions such as endogenous control. Future work should explore this link using more direct, experimental methods.

[3] We also ran a model using helicopter parenting scores and time spent in structured activities to predict verbal fluency scores (R^2=.03; $F(2,30)=1.48$; $p=.24$). In that model, structured time was a highly insignificant predictor ($p>.9$), and helicopter parenting scores remained marginally significant ($p=.10$).

We did not see a relationship between proactive control and either structured or unstructured time. We hypothesized that children participating in more structured activities would have more opportunity to observe adult planning behaviors, which would in turn encourage them to adopt more adult-like organizational skills and develop plans to carry out goals. Were this true, children in structured activities might have more opportunity to practice proactive control more often than children in unstructured activities.. However, since we did not obtain detailed information about the structure and context of the activities children participated in, we were unable to directly test this hypothesis. Therefore, we cannot rule out the possibility that children in structured activities had limited exposure to (or opportunity to mimic) organizational and planning behaviors. Alternately, it may be that the development of planning and organizational skills does not contribute to the development of lower-level proactive control processes. Another possible explanation for why we did not see the expected relationship between child schedules and proactive control is related to the proactive control measure used in this study. The AX-CPT requires children to maintain cues for short periods of time, and therefore may not reflect advances in longer-term planning, or more complex goal-oriented behaviors.

Our unstructured leisure time index consists of the following activities: playing, practicing for physical and non-physical lessons, family outings, parties and social events, and general interactions with parents. We believe that during these activities, children are heavily self-directing. Even when interacting with parents or peers, children can dictate their own behavior. These activities are thought to be qualitatively different from our structured leisure time index, which consists of the following activities: structured physical and non-physical lessons, homework, and religious activities. During these activities, external rules are often placed on the child's behavior, and they must work within those rules. Endogenous control requires that children use internal cues to modulate their behavior, and participation in self-directed unstructured leisure time allows children to practice the necessary skills to exercise their endogenous control.

There are a several caveats to consider with respect to this study. As with all correlational studies, we cannot assign causal interpretations to outcomes. The small sample size (*n*=34) used in this study also limits our ability to measure how robust the relationship is between the structured/unstructured time tradeoff and our outcome variables of interest. Previous survey studies that focus on how children spend their time have used larger sample sizes of *n*>200 (Fiorini, Keane, Fiorini, & Keane, 2013; Meeks & Mauldin, 1990) allowing relationships between variables to become more salient. Additionally, findings from our sample are not easily generalizable to the rest of the population; the children who participated were disproportionately White, and tended to come from mid-to-high SES families.

Scheduling and reporting issues may have also influenced our findings in this study. It is possible that overscheduled parents and/or children may not have had enough time to come into the center, and are therefore not represented in this analysis. Therefore, we may have missed a subpopulation of children who participate in many structured activities, who would have benefited this analysis. Other parents may have forgotten to jot down notes. These parents may have been less likely to recall their child's schedule accurately. Although we attempted to address this problem during recruitment by notifying parents that they were going to be asked questions concerning child activities from the week prior, some parents appeared to be more prepared than others, which may have introduced systematic bias. Additionally, having a mix of mothers and fathers come in also may have caused inaccuracies in the scheduling data, since mothers and fathers tend to report child behavior differently (Gagnon, Nagle, & Nickerson, 2007).

Additionally, future studies should explore other methods that will allow researchers to gain insight into how and when children initiate their own activities. Since self-direction is intimately related to endogenous control, understanding when children direct their activities versus when children are told what to do (even if it's play) may provide a deeper understanding of the relationship between schedules and executive functions.

Finally, this study looks specifically at the relationship between endogenous control and proactive control and child schedules, and thus only utilizes three out of five executive function tasks performed by the children in this study. The other two tasks, the flanker task and the digit span task assess different markers of executive function (inhibition and working memory). Future studies can look at the relationships of overall schedules and individual activities on these makers of executive function. Benefits seen in some executive functions do not necessarily translate to others (Diamond, 2012), so it is possible that specific activities are associated with improvements in either inhibition or working memory.

Conclusion

This study examines child participation in structured and unstructured leisure activities and its relationship to the development of child executive functions, specifically the development of endogenous and proactive control. More participation in unstructured leisure time predicts better performance on an endogenous control task. Higher levels of intrusive parenting marginally predict lower scores on the endogenous control task. Children's schedules do not predict their proactive control. These results provide key insights into the nature of scheduled activities and their relationship to the developing cognition of children. This research further reaffirms the importance of play in child development. Unstructured activities such as play are being displaced as parents have increasingly adopted a structured, hurried lifestyle (Ginsburg, 2007) and this research indicates that reducing unstructured time may come at a cost to developing self-directed behaviors. This research also allows future studies to look more intricately at the causal networks associated with development.

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Appendix 1.

Child Activity Code Book

0) Sleep

1) Eating

Examples: meals and snacks; if combined with other activity, code both separately (ex., dinner and swimming would be coded as 'Eating' and 'Free time/play')

2) Structured physical lessons

Examples: soccer practice or game, dance, baseball, gymnastics

3) Physical lesson practice

Examples: practicing pitching, practicing soccer dribbling, bowling putt-putt golfing [critical distinction: this is child-directed practice for a structured lesson]

4) Structured non-physical lessons

Examples: music camp, art, theater, violin

5) Non-physical lesson practice

Examples: violin or piano practice [critical distinction: this is child-directed practice for a structured lesson]

6.0) Free time and play – alone

Examples: watching TV or movie, coloring, reading, playing outside (all alone)

6.01) Indoor free play alone (if location unknown code as indoor and unknown)

6.02) Outdoor free play alone

6.03) Media/screen time alone

6.04) Reading (free time reading/reading for fun alone – not for joint reading with parents)

6.05) Structured leisure time alone

6.1) Free time and play – with others

Examples: playing tag with sibling, swimming (unless swim lessons), neighborhood kickball game

6.11) Indoor free play with others (if location unknown code as indoor and unknown)

6.12) Outdoor free play with others

6.13) Media/screen time with others

6.14) Reading with others (code with 15 as secondary (parent-child interaction) if reading with parents)

6.15) Structured leisure time with others (e.g. bowling, mini-golf, batting cages – rule based leisure time)

7) Care provided by others

Examples: in daycare, with sitter, with grandparents, give as secondary code: to playing at a friends

8) Homework and studying

Examples: Chinese homework, ‘math time’

9) Chores and housework

Examples: help with dishes, helped mom clean something – give 15 as a secondary code

10) Personal care

Examples: bathing, getting ready/dressed, naps

11) Family outings

Examples: movies, shopping, hiking, errands

11.1) Preparing for Family outings

Examples: Prep for pool, prep to go out, getting ready to go out.

12) Religious activities

Examples: church, Bible study

13) Social event/party

Examples: birthday party, BBQ

14) Child appointments

Examples: doctor/dentist appointment, haircut, speech therapy

15) Parent-child interaction

Examples: family time, cooking, talking with dad, stories from parent, reading time/bedtime stories, watching movies/tv, observing games/practices together

16) Commuting Time

Examples: Drive to/from school

17) School

18) Blank

Instructions: Use if time period when not sleeping or in school is left blank.

19) Unknown

Instructions: Parent response cannot be interpreted.

20) Camps

Use 20 only as a secondary code for things like summer camps (e.g. Sleep away camp give 7 as a primary code and 20 as a secondary)

Appendix 2

Helicopter Parenting Subscale

I can't stand to see my child frustrated by something my child can't do.

I hate to miss any event in my child's daily life

*It is important to let children struggle to figure things out for themselves.

*It is important to me that my child has some out of school time that is unstructured.

It is important to me that my child never fails in activities.

I intervene immediately when I see my child making a bad decision.

It is important to monitor everything that goes on in my child's classroom.

*My child plays alone or with other children, out of sight of adults.

I feel the need to be the voice for my child so that things go my child's way.

I intervene to resolve conflict between my child and my child's peers.

When I leave my child in the care of a babysitter or family member, I check in for updates.

Note: For each item, parents were instructed to rate their level of agreement on a 1-5 scale.

Reverse coded items marked with an *.